РОССИЙСКАЯ ФЕДЕРАЦИЯ -
СОЕДИНЕННЫЕ ШТАТЫ АМЕРИКИ

RUSSIAN FEDERATION -
UNITED STATES OF AMERICA

МЧС

DOE

SECOND WORKSHOP ON

**"STUDIES OF RADIATION EFFECTS ON POPULATIONS IN URAL AND OTHER REGIONS"**

# FINAL REPORT

# on sections 1-3

St. Petersburg

July 11-13, 1995

# Introduction

According to the decision taken at the first JCC RER session which took place in Washington, DC on October 22-25, 1994, two seminars were planned for 1995 with the purpose of getting acquainted with the experience both countries have in the sphere and choosing optimal future joint research strategies.

The first seminar dedicated to the study of consequences of radiation effects on atomic industry professionals took place on March 13-15, 1995 in Florida, USA and the second one whose results are presented in this document took place on July 11-13 in Saint-Petersburg, Russia.

The second seminar focused primarily on the analysis of the research which has been already conducted of the radiation effects on the population of the Ural and other regions of Russia, which have been contaminated as a result of accident situations at atomic industry and atomic energy enterprises, or which have been affected by intensive radioactive fallouts (Altay Region ) as a result of nuclear tests at the Semipalatinsk test site in the former Soviet Union. At the seminar leading experts from both countries analysed the methods used in reconstruction of population exposure doses, assessed strengths and weaknesses of the methods and means to increase reliability and credibility of obtained results.

Considerable attention was paid to epidemiological analysis of stochastic consequences of exposure on the population of the Ural, Altay and other regions of Russia contaminated as a result of the Chernobyl accident. Topics of possible future cooperation were also discussed.

The seminar was mostly conducted in small working group discussions with the participation of approximately equal numbers of Russian and American scientists.

The two seminars managed on the consensus basis to create recommendations on the most effective approach to organization and conduct of joint research in the sphere of health effects of occupational radiation exposure and population exposure, and also in the sphere of defining priorities for future research in both countries.

# Greeting of the First Deputy Minister of EMERCOM of Russia V.A. Vozniak to the Participants of the Second Workshop "Studies of Radiation Effects on the Population of Ural and Other Regions"

Dear ladies and gentlemen!

We are happy to greet you at the opening of the Second Workshop "Studies of Radiation Effects on the Population of Ural and other Regions" being held within the framework of the Agreement between the Government of Russia and the Government of the USA on co-operation in the field of the studies of radiation effects to minimize the consequences of the radioactive contamination affecting human health and environment.

The Agreement was signed one and a half years ago; in this period of time we made marked progress in its fulfillment due to strong mutual interest of Russian and American scientists to the joint work and to the exchange of experience and also due to the complex of problems of moderating the past and probably future radiation consequences of population exposure.

The EMERCOM of Russia is charged by the Russian Government to fulfill the state programs of radiation, medical and social protection of people affected in radiation accidents and catastrophes. These are State programs for protection of the population of Russia against the consequences of the Chernobyl accident, Federal program "Children of Chernobyl", State program for the rehabilitation of the Ural region, State program for the rehabilitation of the population and for social-economic development of the populated areas of Altay region exposed due to the nuclear tests at the Semipalatinsk Polygon, the program of the social support of social-economic development of the Altay republic.

Apart from the practical measurements to increase quality of life of the affected population the state program provide carrying out the large volume of the scientific studies directed at the development of the effective measures of radiation, medical and social protection of population.

Special attention is paid to the evaluation of the remote consequences of the chronical exposure of population, to the retrospective reconstruction of the exposure doses, to the epidemiological studies in the contaminated territories, to the risk evaluation of cancer formations .

EMERCOM of Russia is a state customer of these project and exercises unified methodical leadership of the scientific studies on the territory of Russia affected due to the radiation effects.

Peculiarities of contamination and formating of exposure doses for the population on these territories are essentially different. For the areas of Russia affected due to the Chernobyl accident the most serious medical problem is increased number of children affected by thyroid cancer .To clarify additional morbidity prognosis we plan to continue

Following American and Russian colleges' suggestions, we include in the agenda of the meeting the discussion on the problems of collaboration with the population of the contaminated areas, dose reconstruction for the exposed population and risk assessment for population of other Russian areas, namely, Altay region and territories contaminated as a result of the Chernobyl accident.

I would like for this work to result in formulating problems of mutual interest for the researche in both countries, and submit them to the Executive Committee as proposals for review.

I deeply regret that the circumstances prevent my further participation at this meeting.

I wish you successful work, mutual understanding and friendly atmosphere.

We welcome you in the most beautiful Russian city, and hope that you will find time not only for the fruitful work, but also for visiting some places of interest.

I wish you successful work

**Public Involvement**

We look forward to a session devoted totally to public involvement in scientific studies, as discussed by the members of the JCCRER in October, 1994.

We believe it will prove to be one of the most important accomplishments of this workshop.

We have learned in the US that the time for scientists operating behind closed doors is over. This era has ended. Secretary O'Leary's openness policies extend from uncovering past human experiments to increasing public involvement and transparency in current research.

Earning public trust will promote cooperation among researchers and increase credibility for the results.

An important objective of the workshop is to develop an effective approach and understanding of public involvement and communication.

Our challenges this week are twofold:

First, and in general, to identify best strategies and techniques for advancing scientific understanding but more specifically to develop work plans for our projects.

We also need to integrate consideration of public interests and concerns into research designs.

Thanks in particular to Dr. Pettengill and his staff for their tireless co-ordination of the JCCRER process. I want to thank our Russian colleagues for the opportunity to be here and give special thanks to Dr. Vozniak for his strong endorsement and continuing support for this very important work.

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detectors and electronics are obsolete and there are plans to replace them with modern equipment.

It is highly desirable to ensure that the old measurement system is once again calibrated in depth on the basis of measurements with special anthropomorphic phantoms. Also, measurements of the phantoms with the new system will ensure the comparability of the results with the new and old systems.

Phantoms of two types, namely physical and mathematical, are required for the selection of optimum measurement geometry as well as detector type and for the calibration of the whole-body bremsstralung counter. A physical phantom is an anthropomorphic model of the body of an adult with a uniform distribution of $^{90}Sr$ in the skeleton. Such a physical phantom will be constructed for this project as agreed upon in February. The error in the muscle-tissue equivalent, lung-tissue equivalent and bone equivalent of the materials used will be within 2% for the 0.015 to 0.060 MeV range of gamma energy. The activity error will be less than 5%.

A mathematical phantom is a computer model simulating the spectral and angular distribution of the photon radiation, including bremsstrahlung, at the surface of the phantom resulting from the radioactive decay of incorporated radionuclides. Such a phantom uses the Monte-Carlo method and includes four units:

- the source term,
- the physical constants for radiation transport,
- the geometrical unit, and
- the result interpretation.

The limitations of the computer model are due to the complexity of the body structures. The mathematical phantom is intended to make allowance for a non-uniform $^{90}Sr$ distribution in different bones and structures of the skeleton and for individual body geometries.

Development of the design of the physical $^{90}Sr$ phantom was started in January 1995; it should be completed in December 1995. Manufacture is scheduled to start in January 1996. Calibration of the physical phantom is scheduled to be completed in July 1996. Calibration of the whole body counter is expected to be finished by August 1996.

Work on the development of a mathematical phantom may begin in September 1995, if the project is approved and funding is available. The U.S. scientists will investigate what mathematical phantoms are currently available in the U.S. and whether they might greatly facilitate the development of a phantom for this purpose.

**Milestone 1.1(3). Prepare a report that will include the methodology for and an assessment of the feasibility of reconstructing the doses for persons in the cohort considered in Project 1.2 by February 29, 1996.**

Work on this milestone is being delayed until the completion of Milestone *1.1(4)*. During this workshop there were many preliminary discussions of the methodologies to be used and the tasks that must be completed by different groups.

As noted above, Hanford is considered to be a reasonable analogue for the Mayak complex. During the visit to the Hanford site by the four Russian scientists, there will be

## Appendix 2

# CONCEPTUAL MODEL FOR DOSE RECONSTRUCTION

## JOINT COORDINATING COMMITTEE ON RADIATION EFFECTS RESEARCH

### PROJECT 1.1: DOSE RECONSTRUCTION FOR THE URALS POPULATION

#### Introduction

Project 1.1 involves the calculational reconstruction of radiation doses to the population living around the Mayak nuclear materials production facility in the southern Ural Mountains of Russia (JCCRER 1994). The general outline of activities for the first year of JCCRER Project 1.1 has been approved by the JCCRER and includes milestones related to establishing a database of information, establishing conceptual models of the sources and pathways of exposure, and establishing the feasibility of and methodology for reconstructing the radiation doses.

This report describes the results of activities to establish a set of conceptual models that define the relationships, pathways, and parameters that will form the basis of the dose reconstruction efforts. These conceptual models must be determined before any computational scheme can be developed. These models were developed at a meeting in July 1995 in St. Petersburg, Russia. This report describes the conceptual models agreed upon by the contributing scientific organizations.

#### Primary Sources and Pathways of Exposure

The reconstruction of radiation exposures to people living in the vicinity of the Mayak facility is potentially very complex. A graphical depiction of the primary sources of release, and the resulting primary ways the public was exposed from these releases, is shown in Figure 1.

During the first decade of operation of the Mayak facility, gaseous and particulate radionuclides were released to the atmosphere in large quantities. Of potential public concern is the release of plutonium-239. Elevated levels of plutonium have been measured in the people living around the Mayak facility to distances of up to 100 km (Suslova et al. 1995). This plutonium would have been released through routine ventilation of the processing facility. The main pathway of exposure to plutonium is inhalation, both during passage of the released plumes and afterwards as a result of resuspension.

In a manner analogous to that at the Hanford Site in the United States (TSP 1994), iodine-131 was also released to the atmosphere from routine processing operations (Khokhryakov et al. 1995). Iodine-131 is a radionuclide that deposits readily on vegetation and can be taken in by grazing cattle and transferred to milk. Production records and meteorological data are available for estimating the releases of iodine-131 and plutonium and their subsequent environmental distribution.

Other radionuclides were also emitted into the air during facility operations. Screening studies indicate that the doses resulting from these releases are relatively small.

The Kyshtym explosion, creating the East Urals Radioactive Trace, resulted in cumulative external doses to unevacuated populations reaching 4 to 50 rad (Romanov 1995).

The large releases to the Techa River created a number of significant exposure pathways. Radionuclide concentrations exceeded 100 rCi/L in the early 1950s, with consequent concentrations in sediments as high as 10 mCi/kg and concentrations in garden soils also very high (Goloshchapov et al. 1995). The external dose rates were quite high (Burmistrov et al. 1995); cumulative doses as measured using environmental thermoluminescent dosimeters exceed 100 rad. The people living in villages downstream frequently had no other sources of drinking or sanitary water. Direct ingestion of drinking water is a straightforward pathway. Consumption of milk from cows feeding the region also lead to large doses. Anecdotal evidence also indicates that fish from the river were frequently consumed.

It is apparent that there are several sources that should be followed, and that the timing, pathways, and magnitude depend on both the source and individual habits.

### Minor Pathways of Exposure

Initial calculations indicate that the routine releases of plutonium did not result in lung or bone doses to members of the public in excess of 10 rads. Similarly, the total release by resuspension from Lake Karachai beyond the boundaries of the Mayak facility were not sufficient to result in large depositions. (However, there is still some question about the inhalation doses resulting from this release.) Although numerous pathways can be postulated for use of Techa River water in the homes of local residents (e.g., washing clothes, washing floors), most will result in doses less than ingestion and direct external exposure. While scoping studies to refine the dose estimates for these various pathways should be performed, resources should be conserved to deal with the major pathways.

### Bioassay Data Supporting Dose Reconstruction

The majority of the environmental exposures to short-lived radionuclides have not left currently-detectable signals in the exposed populations. However, some of the longer-lived radionuclides, with long biological residence times, still may be detected.

Human body burdens of plutonium have been measured at levels above global background in the population out to distances of 100 km (Suslova et al. 1995).

A small amount of data is available for people (whole body counts) following the Kyshtym release. This is not a sufficient amount upon which to base dose estimates, but it may be used to validate release and uptake estimates.

Strontium-90 also has a long biological residence time in the body. The levels of environmental contamination are sufficient that strontium/yttrium bremmstrahlung may be detected from outside the body. Measurements of individuals have been made for many years - over 15,000 people are enrolled in the registry with whole body measurements (Kozheurov 1995). Available instrumentation permits evaluation of minimum detectable activity in whole body in terms of Sr-90 at about 120-150 nCi. So the Sr-90 content of the skeleton for about 80% of the living Techa River residents is at present under 200 nCi. In order to continue the radiometric screening of the population,

### Individual Specific Dose Reconstruction

Just as certain sources and pathways as adequately dealt with in generic terms, certain doses must be reconstructed specifically for the individual, because the doses are sufficiently large to be important and because individual habits are sufficiently variable that a generic answer will not provide adequate detail to support epidemiological studies.

The sources and pathways requiring individual specific dose reconstruction are illustrated in Figure 7. These calculations require detailed histories of residence, food consumption, and personal lifestyles.

Dose reconstruction requires calculations based on models. However, in-vivo measurements and/or ESR and FISH techniques can provide powerful support and validation for the calculations.

### Evaluation of the Feasibility of Dose Reconstruction

A large database of environmental measurements of radionuclide concentrations in soil and other media exists. This database is sufficient to provide the bulk of the required inputs for individual specific dose reconstruction for the pathways illustrated in Figure 7.

Additional efforts are required to provide detailed time-histories of the atmospheric releases of the dominant and subordinate radionuclides from Mayak stacks. Additional documentation of the releases from Lake Karachai are also needed. The generic dose calculations will remain incomplete without this supporting information.

It would be best if records from the production facility were available to do this. Such records would provide the best documentation and also provide the greatest public acceptability of the results.

### Required Activities

The investigators from both countries have agreed on a basic program of inquiry. The various discrete tasks are listed below.

Items related to the Techa River:

1. Reconstruction of radionuclide release sources
2. Work on archived data processing, development of database of radionuclide contents of environmental media (soil, water, vegetation).
3. Development and verification of hydrological model for radionuclide transport and sedimentation in the Techa River.
    - verification of methods; comparison to archive data
    - new measurements of long-lived radionuclide content in water, sediments, floodplain soils.

4. Reconstruction of dose from external exposure.
    - 4.1 Development and verification of the model for the dose rate field in air.
    - 4.2 Refining of modifying factors, including lifestyles of different population groups

3.2 Verification of the models against results of radionuclide behavior studies in the Mayak area.

3.3 Planning of the manufacturing database structure for radionuclide content in the food chain

3.4 Filling the inputs for the database

3.5 Uncertainty and sensitivity analysis methods development and incorporation in the mathematical models

4. Development of Dietary Intake models

4.1 Development of mathematical models

4.2 Planning of the database structure

4.3 Filling the inputs for the database

4.4 Uncertainty and sensitivity analysis methods development and incorporation in the mathematical models

5. Development of lifestyles of the exposed population

6. Reconstruction of doses for the population of Chelyabinsk-65 resulting from atmospheric releases

**Subcontracting Organizations**

*Branch 1 of Moscow Biophysics Institute, Ozersk:*
plutonium analyses and data

*Institute for Hygiene of Sea Transport, St. Petersburg:*
phantom design and construction and whole body counter modernization

*Metal Physics Institute, Ekaterinburg:* ESR support

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# Section 2

## PROJECT 1.2

The members of the workshop group recognize the importance of the work already completed by the investigators at URCRM as described in their Workshop presentations. Those reports and the comments and questions they generated, led to fruitful discussions regarding the direction of the research to be undertaken as part of Project 1.2 "Risk estimation for the stochastic effects of radiation exposure and the results of actual observations of the population health in the region of the Industrial Association Mayak." The discussions of the working group covered four areas: what data are available, findings from current studies, methodological issues to be addressed as part of the study project, and suggested future directions. This report will be supplemented by an appendix providing additional information relevant to the design issues noted in the attachment.

**Data currently available.**

The Urals Research Center for Radiation Medicine (URCRM) has been studying the consequences of radiation accidents in the south Urals region for the last 44 years. There are two computerized registries of people exposed to chronic radiation The first registry includes 26,437 people who were exposed to radiation wastes released into the Techa River between 1949 and 1956. For these people, the estimated red bone marrow doses range from 20 to 4000 mSv. The second registry includes information about 20,463 individuals living in the region of the East Urals Radiation Trace (EURT) who were exposed to radiation from the "Kyshtym" accident. The estimated doses for these people are between 15 and 900 mSv. This registry also includes information on 3,500 persons exposed in utero and 32,941 children of exposed parents. The computer base includes demographic and residency information. The medical data base includes information about vital status, causes of death, and morbidity. These data bases are currently being documented in detail.

**Results from current studies.**

Preliminary epidemiologic studies of the cohort follow-up through 1983 show an excess risk of leukemia (excess relative risk = 3.19 per Gy; excess absolute risk = 0.85 per 10,000 person year Gy). An elevated risk of solid cancer was also observed (excess relative risk = 0.65 per Gy). There appeared to be some evidence that mortality due to malformation was increased. These estimates are subject to a large number of uncertainties.

**Methodologic issues.**

The workshop focused on the epidemiologic methods, used to date, for the South Urals Region cohorts. During the discussions questions centered around the nature of the exposed cohorts, control populations, and follow-up methods. The following issues were discussed:

a) Cohort definition: A clear and strict definition of the Techa River and EURT cohorts is needed. Criteria for inclusion must be described in detail.

session when they are in Chelyabinsk. Their report on these topics should be incorporated as an addendum to the workshop report.

e) Data from studies conducted by investigators not from URCRM should be noted in a summary of existing research on the South Urals radiation exposure so that the researchers involved in the JCCRER studies would be aware of all existing data.

f) The possibility of conducting cancer epidemiology studies on the EURT cohort should be considered.

g) The dose reconstruction project should provide doses with their uncertainties and their work should be closely coordinated with the epidemiology project. In general, misclassification and measurement error will lead to downward bias in risk estimates.

Types of loss to follow-up

How are deaths without death certificate handled

Are follow-up procedures the same for all people in the same cohort

Are follow-up procedures the same for people in different cohorts

MIGRATION ISSUES

How do you know when someone migrates

What information is available for migrants

Where do migrants go

How often is migration data updated

What factors influence migration rates

What biases might be associated with migration

PLANS FOR RETROSPECTIVE EXTENSION OF FOLLOW-UP FROM 1983 TO PRESENT

PLANS FOR A SYSTEMATIC ONGOING FOLLOW-UP PROGRAM

What are the primary outcome measures / endpoints

Describe primary data elements in data base

# Report from the Plenary Session

# Public Involvement:

# Real problems for populations in areas contaminated by radiation.

**St. Petersburg, 12 July 1995**

*Co-chairs:* *L. Anissimova (Russia)*
*S. Galson (U.S.)*

**Introduction:**

This session considered how Project Research Teams could meet requirements for public involvement contained in the research guidelines approved by the JCCRER. In her introductory remarks, L. Anissimova said that it is important to consider social and psychological impacts of radiation in radiologically contaminated areas. Speaking for the United States, S. Galson said that the U.S. attaches great importance to effective public involvement in the joint radiation effects research because it will permit researchers to obtain the most accurate and important information they need from the population, and because it is necessary for scientists to earn public trust and credibility for the research results.[1]

**Presentations:**

The session heard presentations from the Russian and U.S. sides. I. Linge stressed the importance of three factors in improving decisionmaking in the aftermath of accidents. First, officials need to be able to consider the quality of available information and its effect on the public. Second, scientists have an important role to play in providing both technical input to decisionmaking and authoritative backing to the decisions that have been made. Third, practical training is important for preparing officials to deal with eventual problems or catastrophes. Effective response in all cases depends upon the preservation of public trust which is quickly lost if officials actions are viewed as technically incompetent or ill-advised.

J. Shideler spoke about public involvement as practiced in the U.S. He described the U.S. Department of Energy's experience with public involvement since the 1980s, and explained the approach currently used by the Department and other U.S. agencies. He explained how U.S. government agencies and private enterprises integrate public involvement in their project planning. He concluded with a description of the role of public involvement in scientific research and the benefits that can be expected from it.

**Public involvement in radiation health studies.**

Public involvement is useful in many aspects of public health research, from defining the mission to analyzing data and interpreting results. In government sponsored research, public involvement is particularly important due to the public's dual role as both funders and subjects of research. Public involvement can help to secure the cooperation of study subjects and to solicit information from residents of contaminated areas. It may play a role in stimulating persons who have become fatalistic and passive in response to the stresses of living in contaminated areas. Public involvement also opens channels for the feedback of public opinion to researchers and serves as a consensus-building mechanism when members of the public hold divergent views on issues of a scientific and social nature.

**Recommendations:**

In accordance with the stipulations of Clause IV of "APPROVED GUIDELINES FOR CONDUCTING SCIENTIFIC RESEARCH PROJECTS UNDER THE AGREEMENT ON CO-OPERATION IN RESEARCH ON RADIATION EFFECTS":

- "...In addition, each PRT shall develop and implement a public involvement plan designed to facilitate communication concerning the nature of the project and the project research results to the public at large."
- "Prior to the publication of results, the PRT co-chairs from each side will inform the EC of their plan for communicating these results to the scientific community and the public. The EC and the JCCRER may advise the PRT on mechanisms and plans for release of results. Public release of research results should occur within one year of completing data analysis."

The follwing recommendations are submitted for considerations by the EC:

1. It is suggested to create a bilateral working group dealing with public opinion, involvement of the population and interested parties in the implementation of the projects being held within the framework of the agreement. This bilateral working group will develop guidelines for the research groups to use in preparing public involvement plans and provide technical assistance throughout the projects. The work of the group must be closely related and co-ordinated with the work of the project research groups. The bilateral working group should be composed of volunteers, and confirmed by the Executive Committee.
2. Regardless of the creation of the bilateral working group, it is recommended to EC to consider mechanisms for evaluation of effectivness of the public communication efforts and public involvement in the research projects implemented within the framework of the agreement.

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